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9.8 A COMPARISON OF MESOSCALE MODEL FORECAST ACCURACY USING RANDOM AND A SIMPLIFIED TARGETTING APPROACH

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1. Introduction

The error in mesoscale model forecasts on the West Coast of the United States often depends strongly on the quality of the synoptic scale forecast. Kuypers (2000) demonstrated that small differences in synoptic scale initial analyses due to different random samples of the large scale structure are sufficient to cause large errors in the mesoscale forecast. This dependence of the mesoscale on the synoptic scale is often mirrored in statements like, "A good mesoscale forecast requires a good synoptic scale forecast." The method by which a good synoptic scale forecast is achieved is the subject of numerous efforts at improving the observations over the Pacific through targeting of observations.

The primary efforts at targeting have relied upon the use of sophisticated schemes (adjoint sensitivity, ensemble transform) to define the dynamically important regions where small initial error adversely projects onto forecast error. These approaches yield a complicated pattern of sensitivity, which must be sampled observationally to most effectively reduce forecast error. It is this sampling requirement that challenges the targeted observing methods and can often produce degradation of forecasts in regions away from the verification region. It is this sampling issue that is explored in this investigation using a very simple approach by which observation locations are determined based on the estimated synoptic-scale structure over the Pacific.

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2. Experimental Design and Targeting Approach

This study is aimed at examining a simplified targeting approach through a series of controlled observing system simulation experiments (OSSE's). The OSSE's were conducted by using one model as a representation of the atmosphere and another model to conduct data assimilation experiments with the manufactured observations from the other model. For these experiments, the Navy's Coupled Ocean Atmospheric Mesoscale Prediction System (COAMPS) model was run in a simulation mode over a two week period in January 1999. This simulation was taken to be the true atmosphere from which observations were extracted as needed for the OSSE's.

To test the impact of various sampling strategies on the subsequent synoptic and mesoscale forecast errors, two different sampling experiments were done. First, a technique was done to determine the locations that must be observed in order to define a given atmospheric structure. This technique is based on taken a given atmospheric structure and systematically finding the scattered points that define the structure when analyzed using the multiquadric scheme described by Nuss and Titley (1994). For example, the sea-level pressure analysis is shown in Fig. 1 along with the set of scattered points that are required to analyze this field completely to an accuracy of 1 mb root mean squared error (RMSE). If the depicted structure was in fact the actual atmospheric structure, the selected points would represent optimal observing locations to define this structure at the scale represented in the analysis. While this can easily be applied to the analyzed structure, the technique is useless as a targeting method unless it is applied to a forecast.

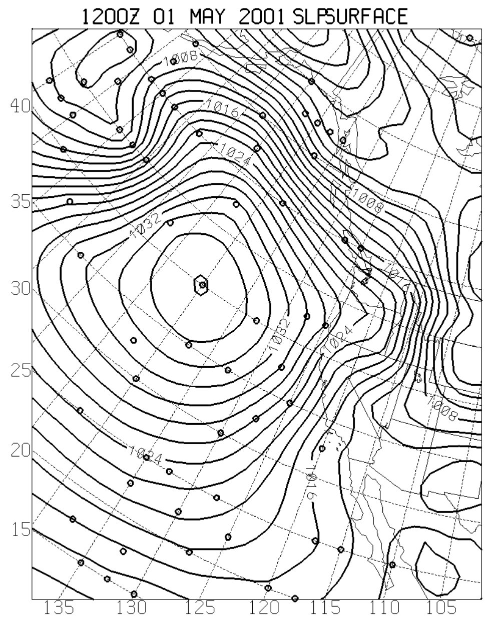

Fig. 1 – Mean sea-level pressure analysis from 01 May 2001 at 1200 UTC showing the required scattered points to define the structure. Only points over the ocean are included.

To test whether this optimal sampling strategy could be effectively applied as a simple targeting method and to examine the relationship between optimal sampling and forecast error, the set of observations needed to fully resolve the structure on the synoptic scale in a 36 h forecast were used to define the observing locations. The observation points were determined from a 36 h forecast from the NPS MM5 model forecast valid at the analysis time. This assumes that the 36 h forecast structure is likely to be close to the actual structure in order to have the predicted observation points be optimal for the actual observed structure. The observations were then extracted at the specified locations from the COAMPS simulation (assumed to be the true state of the atmosphere) and then inserted into the data assimilation procedure for the NPS MM5 forecast system. If there were no error in the 36 h forecast that defined the points, then the resultant observation points would optimally sample the simulated atmospheric structure. However, given that there is error in the 36 h forecast, the set of selected points is less than optimal to define the actual atmospheric structure. The question we are attempting to answer is whether this sampling strategy, even though its sub-optimal, is sufficient to routinely reduce forecast error in the 36 h forecast.

This approach is then compared to randomly sampling the COAMPS atmosphere with the same number of observations over the same domain. The random sample and directed sample experiments highlight the difference in forecast error due to poor sampling of large-scale structures. Although dynamically-based approaches should yield the same basic result, the ability to resolve the complex structure in the dynamically-sensitive regions is problematic and a method that highlights the observations necessary to properly sample the structure or sensitive regions to more completely resolve the structure may be helpful. This approach is aimed at this sampling problem.

3. Summary

Two sampling strategies are compared for their impact on 36 h forecast error. One is based on a mathematical technique that determines the sample required to define the structure in a 36 h forecast valid at the analysis time. This forecast sample is then used to extract synthetic observations from a simulated atmosphere. This is compared to a random sample of the same number of observations. Results to date suggest that analysis error is favorably reduced compared to a random sample when the points are defined using the 36 h forecast for a few cases that have been tested. The impact on the forecast error and a more thorough application to additional cases during the two week period will be presented in the talk.

4. References

Kuypers, M.A., 2000: Understanding mesoscale error growth and predictability. M.S. Thesis 114pp, Naval Postgraduate School, Monterey, CA 93943

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